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13. ABSTRACT *(Maximum 200 words)*

The intent of this project was to study the operation of a Smith-Purcell FEL (SP-FEL) when driven by the short, high-power, relativistic electron micropulses produced by the NCCU Electron Gun. The motivation was the development of an SP-FEL that would bridge the wavelength range from the sub-mm up to the infrared, a wavelength range for which an easily tunable, coherent source would be a major advance. During the period of this project, the electron gun, the interaction chamber, gratings, and the diagnostic systems were developed to conduct the proposed study. The spontaneous radiation generated when the electron beam passed over a grating was studied. The initial conclusion is that Smith-Purcell radiation from the grating was mixed with a significant amount of transition radiation, produced when portions of the relativistic electron beam strike the body of the grating. The strength of the Smith-Purcell radiation compared to the transition radiation suggests that, at least for the experimental conditions used in this experiment, the coupling of the electron beam to the grating was inefficient.

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Development of a Smith-Purcell Free Electron Laser Driven by the NCCU Microwave Gun

FINAL PROGRESS REPORT

Dr. C. R. Jones

December 28, 2000

U. S. ARMY RESEARCH OFFICE

DAAJ04-96-1-0258

NORTH CAROLINA CENTRAL UNIVERSITY

Problem Studied

The major emphasis of this project was to study the operation of a Smith-Purcell FEL (SP-FEL) when driven by the short, high-power, relativistic electron micropulses produced by the NCCU Electron Gun. The motivation was the development of an SP-FEL that would bridge the wavelength range from the sub-mm up to the infrared, a wavelength range for which an easily tunable, coherent source would be a major advance.

Summary of Results

Initially, a considerable portion of the effort was expended to improve the electron gun system and modify it to upgrade the status of the Radiation License from commissioning to operational. During this period, upgrades were also made to the interaction chamber. Subsequently, efforts were directed to improving the optics and equipment for spectral diagnostics. Finally, in the project's third year, a grating was installed in the interaction chamber and the spontaneous radiation generated when the electron beam passed over the grating was studied. Initial studies of the radiation suggest that in this experiment the Smith-Purcell radiation (SPR) from the grating was mixed with a significant amount of transition radiation (TR), produced when portions of the relativistic electron beam strike the body of the grating. Since the SPR from the grating is the primary interest for this project, there is a need to improve both the focusing of the electron beam and the alignment capability of the grating holder in order to generate predominantly SP radiation. Improvements along this line have been designed but not yet fabricated. The strength of the SPR compared to the TR does suggest that, at least for the experimental conditions used in this experiment, the coupling of the electron beam to the grating was inefficient. Theoretical calculations have been undertaken to develop gratings with improved efficiency.

Publications

"Single Bunch Injection System for an Electron Storage Ring Using an RF Photoinjector", Applied Physics Letters, July 20, 1998, Volume 73, Issue 3, pp. 411-413.

"Coherent Transition Radiation Produced by a 1.2-Mev Electron Beam" in Micro Bunches Workshop , Upton, NY, AIP Conference Proceedings 367, 350 (1996).

Scientific Personnel

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Inventions

None